Fletcher & Riley

Effect of Frequency In Alternating Incandescent Lighting

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EFFECT OF FREQUENCY IN ALTERNATING INCANDESCENT LIGHTING

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

CARL JOSHUA FLETCHER and GEORGE ALBERT RILEY

ENTITLED EFFECT OF FREQUENCY IN ALTERNATING INCANDESCENT LIGHTING.

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Electrical Engineering

Morgan Brooks.

HEAD OF DEPARTMENT OF Electrical Engineering.

The increasing use of a lower frequency by eminent engineers , for plants furnishing both power and light has brought up the question of the effect of a lower frequency upon different kinds of electric lamps, and more especially upon incandescent lamps. Although the low frequency is generally used to furnish power to operate isolated sub-stations,which may in turn, change the alternating current to direct current by means of converters, it would be very convenient if a current suitable for lighting purposes could be obtained by simply using a transformer which supplies the required voltage but does not change the frequency.

On account of the lack of satisfactory data on the subject it was desired to test lamps at different frequencies, and if possible devise some method of measuring the effect of different frequencies , and if possible devise some method to measure the effect of frequency upon the incandescent lamp.

The current given by an alternator has values which theretically follow asine wave, passing rapidly from a positive maximum to a negative maximum value, thus giving two points of maximum value for each period. Since the light emitted by an incandescent lamp is due to the square of the current, the reversa of the current does not effect the light, which will always be positive. The varying current however causes the intensity of the light to vary,becoming less as the current decreases and

[illegible]

increasing again as the current rises. The light does not become zero at the point where the current is zero however, because this point is passed so quickly the filament does not have time to cool entirely.

It was first desided to test the effect of frequency upon the eye, and this was done in the following manner. In order to eliminate as far as possible the difference due to different eyes and to obtain the true effect of frequency, the test was carried on individually by Mr. Riley and Mr. Fletcher. The lamps tested were placed in a dark room which had no reflecting walls or surfaces, and various frequencies were impressed upon the lamps.

The results of the test as noted by Mr. Riley were as follows.

The test was started at a frequency of 60 and no change was noticed either by looking directly at the filiament or by the light being thrown upon a white screen. The frequency was then changed by small steps until a flickering was noticed. This flickering, which was due to the low frequency, was first noticed by watching the shadow on the screen used as stated above and first appeared at a frequency of twenty-seven (27), but could not be noticed at thirty. These changes could not be noticed when looking directly at the filiament until the frequency had been

lowered to about twenty (20). There was a noticable unsteadiness in the filiament at the lower frequencies, which became more noticeable as the frequency was lowered.

The test by Mr. Fletcher was as follows.

To determine the point at which the lamp actually flickered, due to low frequency, it was necessary to note the point at which there would be rapid changes in the color of the filiament. The frequency was lowered from sixty (60), and the flicker was observed at a frequency of twenty-two (22). Toward the latter part of the test the effect was very trying to the eyes, and it was necessary to rest them before any farther observations were taken. Again starting at the low frequency it was desired to raise it very slowly and note effect. A slight rise in frequency caused the filiament to give apparently steady light, but the light reflected from a white surface was unsteady, even when the frequency was at twenty-eight (28) although the flickering disappeared at thirty (30).

In order to try the effect of the low frequency on the eyes, the filiament of a direct current lamp was watched closely for a given time, and after the eyes were rested the same was tryed with the alternating current lamp at a frequency of twenty-five (25). The alternating current lamp was found to be much more trying to the eyes although the variations of the light could not be

seen.

These tests would show that for general illumination, such as stations, power plants, and all places where close application of the eyes is not necessary, a frequency of twenty-five (25) may be used; but for lighting where the eyes are to be used to any extent, the frequency should not be below forty (40). Although the rapid variations could not be seen, they would undoubtedly be injurious to the eyes. At frequencies of thirty (30) and below the filiaments tend to vibrate, which greatly increases the effect and makes the light more trying. If incandescent lamps must be used on low frequency, the filiament should be anchored in such a manner as to reduce all possible vibration, and lamps of high candle-power with thick filiaments should be used.

An endeavor was made to measure the effect of frequency more accurately than is possible with the eye, and to determine if possible any laws that govern the difference between the maximum and minumum intensity of light at the different frequencies. By means of a slotted disk running in synchronism with the alternating current impressed upon the lamp, we endeavored to cut off all the light except at maximum and minumum points, and to measure the difference by the aid of a photometer. To do this a small eight (8) pole alternator was arranged to run as a single phase synchronous motor, being started and brought up to synchronism by

means of a small direct current motor belted to it. The synchronous motor was on the same circuit as the light to be tested, in order to run it with the same frequency. Slots were cut in a large pasteboard disk and accurately spaced to one eighth of the circumference, thus allowing only certain portions of the light curve to pass through the disk. The spacing of these slots was determined by the number of poles on the machine, there being eight (8) slots because the frequency of the light wave is double that of the current from which it is run.

The disk was made to revolve in front of a Bunsen grease spot photometer which was lighted from one end by a direct current lamp , the low frequency lamp being placed at the other end. If the screen on the photometer responded accurately to the variations in intensity of light from the alternating current lamp, and the revolving disk allowed only the maximum and minumum light to be seen , the difference in candle-power should be shown by the appearance of the grease spot on the photometer screen.

The different points on the light curve were observed by moving the photometer screen a distance of one half the distance of the spacing between the slots on the disk, thus giving all the values of the curve, the difference in the intensity of light being measured by the ratio of the distance of the direct current lamp from the screen, to that of the alternating current

lamp from the screen.

At low frequencies the photometer showed a difference in candle-power between maximum and minumum points; but it did not respond satisfatorily to the variations of light, and also, the persistency of vision made it necessary to reduce the width of the slots to such an extent that too much of the light was cut off, thus making the readings indeterminate.

Every precaution was taken to make this test accurate, all parts of the motor and disk being blackened, to prevent any reflection of light.

While the results of these tests were not as definite as had been hoped for, and the conclusions to be drawn are only negative, the fact that a rapid variation of light does exsist even at sixty (60) has been proven, and that at low frequencies the effect is very appreciable and is a factor which cannot be overlooked.